Incentives and managerial effort under competitive pressure: an experiment

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Abstract

We investigate how increased competition affects firm owners’ incentives and managers’ efforts in a laboratory experiment. Each owner offers a compensation scheme to his manager in two different conditions: under monopoly and under Cournot duopoly. After accepting the compensation, the manager chooses an effort level to increase the probability of a cost-reduction which affects the firm’s profit. According to standard theoretical predictions the entry of a rival firm in a monopolistic industry affects negatively both the incentive compensation and the effort level. Our experimental findings show that the entry of a rival firm has two effects on managerial effort: an internalization effect which affects positively the level of effort and an income effect which has a negative impact on effort. The combined outcome of these two effects is neutral with respect to managerial effort: we observe that when competition reduces the firm’s profit, the owner reacts by offering lower incentives but despite the lower incentives the manager still accepts the contract offer and exerts the same level of effort as under the monopoly condition.

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1. Introduction

The impact of competition on incentives to provide managerial effort is a key issue both for theory and for business practice. The underlying question is how to design optimum incentives in a context where firms compete. The answer rests on a clear understanding of the manager’s reactions to an alteration of the incentives provided by the owner in reaction to increased competition.

The empirical literature on the relationships between competition, incentives and managerial effort is rather scarce because of the methodological difficulties to establish such links empirically. In their seminal paper Jensen and Meckling (1976) found a weak correlation between the manager’s compensation scheme and the firm’s performance. However, Hall and Liebman (1998) found a strong and positive correlation between firms’ performance and managers’ compensation. A few papers (Nickell, 1996; Cuñat and Guadalupe, 2005; Baggs and De Bettignies, 2007; Beiner et al., 2011), studied the effect of competition. These papers focused on the impact on incentives, productivity or agency costs. Their main findings can be summarized as follows: increasing competition on the product market has a positive effect on employees’ productivity (Nickell, 1996), on managers’ incentives (Cuñat and Guadalupe, 2005, Beiner et al., 2011) and a negative effect on agency costs (Jagannathan and Srinivasan, 1999; Baggs and De Bettignies, 2007). All these studies have serious weaknesses because of methodological limitations. First, it is both difficult to observe and to measure a change in competitive pressure and in the level of managerial effort. Even if the variation of competitive pressure could be isolated, data on incentives and efforts are usually unavailable because managers’ efforts are typically unobservable. Second, each of the mentioned paper focused on some particular variable that might be affected by competition (incentives, effort or agency costs) precluding thereby global assessment of the impact of increased competition on the relations between these variables.

Controlled laboratory experiments represent a powerful tool to overcome some of the limitations of the existing empirical studies. For instance, they allow the researcher to produce the relevant type of data that is needed for answering clearly the research question that is at stakes. Of course, laboratory experiments have also limitations compared to other empirical methods. One of them is the available subject pool. For instance, standard subjects (i.e. students), often behave differently from the targeted population or from the general population (see e.g. Cooper et al. (1999), Fehr & List (2004), Alevy et al. (2006), Croson & Gneezy (2009), Alatas et al. (2009), Bortolotti et al. (2013)). Although subject pool effects represent a serious concern, most of the researchers just cited also acknowledge that laboratory experiments are useful because they allow to control for many confounding factors that affect natural data.

In this spirit, we set up a controlled environment that allows us to observe precisely and without ambiguity whether and how the level of profit of a firm is related to the incentive scheme offered by the firm’s owner and how these incentives affects the manager’s effort choice. We capture increased competition by considering a Cournot duopoly situation after the entry of a new firm in a formerly monopolistic industry. The monopoly case is taken as the benchmark situation because it corresponds to the standard theoretical case in which managerial incentives are independent of the firm’s competitive environment. We assume that the managers’ task is to choose a level of effort which determines the probability of a cost-reducing innovation. The principals (owners) do not observe their manager’s effort. Since they cannot reward the manager’s effort they condition the incentives on the level of realized...
profit. The design of the experiment relies on a simple principal-agent model that predicts each agent’s choice in the monopoly and the duopoly situations.

The experiment relates on a within-subject design that allows us to study how managerial incentives of the (former) monopoly firm are adjusted after a second firm has entered into the industry. In a first sequence the firm has no rival and we can therefore observe the principals’ contract offers and the managers’ effort choices without competition. In a second sequence the entry of a second firm in the industry challenges the monopolists’ profits who expect a lower profit level compared to its former monopolistic profit. We observe how principals react by adjusting the incentives provided to their managers and how the latter respond by adjusting their levels of effort. We control for order effects by running a second treatment where the ordering of sequences is reversed.

Our main findings are as follows: duopoly firms offer lower incentives than monopolistic firms, but managers accept the less attractive contract offers of the duopoly firms and maintain their effort level despite the reduced incentives. On one hand, the observation of a positive relation between expected profit and managerial incentives is in accordance with the theoretical literature (Hermalin, 1992; Schmidt, 1997). On the other hand, in contrast to the theoretical literature, the relation between incentives and effort is not always positive. By moving from the monopoly to the duopoly situation in which the firm’s expected profit is reduced because of competition, principals provide lower incentives but managers maintain their effort level.

We interpret our findings as follows. Increased competition has two effects on managerial effort: an internalization effect and an income effect. According to the internalization effect managers internalize the competitive pressure by providing higher effort to preserve the competitiveness of the firm. The firm can therefore implement a higher effort level at a lower cost. According to the income effect competition reduces the firm’s expected profit and therefore the owner lowers the incentives and the manager lowers his level of effort. The internalization effect and the income effect cancel out on average.

The remainder of the paper is organized as follows. Section 2 presents the theoretical predictions. Section 3 describes the experimental procedure. Section 4 contains results. The first part of Section 4 analyses principals’ contracts offer. In the second part of Section 4, we analyses in detail agents’ decisions. Section 5 gives a summary.

2. Theoretical background

In this section we provide a theoretical background that will be useful for framing the design of our experiment. We introduce a simple model that allows us to compare managerial incentives under monopolistic and competitive market structures. We restrict the analysis to the comparison of such incentives between a monopolistic firm and a Cournot duopoly on the product market. Before we introduce our model, we provide a brief review of the theoretical literature.
2.1 Literature review

The theoretical literature has identified three main effects of competition on incentives and on the manager’s choice of effort. These effects were respectively called: the informational effect, the manager's utility effect and the income effect. Although our experiment focuses on the income effect, we shall briefly describe each of these effects.

According to the informational effect increased competition refines the owner’s information structure (Holmstrom, 1982; Hart, 1983; Nalebuff and Stiglitz, 1983; Scharfstein, 1988 and Hermalin, 1992) which enables him to monitor more effectively the manager’s effort. For instance, such informational effect can be due to a common shock that affects factors prices as in Hart (1983) affecting therefore prices on the product market if there is competition on this market. Similarly, in Nalebuff and Stiglitz (1983) and Scharfstein (1988) the principal can rely on additional signals under stronger competition to infer the manager’s actions. However, as shown by Hermalin (1992), the informational effect remains ambiguous because the manager may either choose more or less effort under increased competition depending on his preferences (risk-attitude).

The manager's utility effect corresponds to a direct impact of competition on managers’ effort choice (Hermalin, 1992; Schmidt, 1997) driven by the threat of losing the bonus or being fired. The manager reacts to increased competition by raising his effort level to prevent bad performance, without requiring stronger incentives.

According to the income effect competition affects indirectly the incentives provided by the owner through the impact on the firm’s profit (Hermalin, 1992; Martin, 1993; Horn et al., 1994; Schmidt, 1997; Raith, 2003; Baggs and De Bettignies, 2007). Without ambiguity the owner simply increases (lowers) the incentives if the expected profit increases (falls) and the manager adjusts his/her effort accordingly. According to this stream of literature the manager adjusts her effort only in response to incentives offered by the owner, but not directly in response to the change in competition as hypothesized by the manager’s utility effect. If competition becomes fiercer, the manager provides exactly the same level of effort as long as the incentives proposed by the owner are unchanged. On the other hand, if competition leads the firm to increase (reduce) managerial incentives the manager responds by increasing (lowering) her effort. Thus according to this literature there can be either a negative (Martin, 1993; Horn et al., 1994; Schmidt, 1997) or a positive relation (Raith, 2003) between competition and the firm’s profit, but the relation between the incentives and the manager’s effort is independent of competition. In the remainder of the paper we concentrate on the income effect. Our aim is to isolate the impact of increased competition on the owner’s choice of incentives and on the manager’s choice of effort. In particular, if the owner adjusts the incentives in response to a change in competitive pressure, does the manager respond only to the variation of incentives or does he also react directly to increased competition as predicted by the manager’s utility effect?

We first introduce the model before discussing the outcomes for the monopoly and the duopoly case.
2.2 The model

We consider a market with 2 firms, \( i \) and \( j \), producing a homogenous product and facing a linear demand function, \( p(Q) = a - Q \) where \( Q = q_i + q_j \). The number of active firms in the market is either one (monopoly) or two (duopoly). Each firm is an agency that is composed of a single principal (the owner) and a single agent (the manager). The manager’s effort affects the firm’s marginal cost. We assume that for each firm, it can take one of two values: \( c_l \) (low) or \( c_h \) (high), with \( 0 < c_l < c_h \). Initially, each firm faces the high cost level, \( c_h \). Managers can decide to make costly efforts that increase the probability of a successful innovation that reduces the firm’s marginal cost. The chosen effort is not observable by the principal who only observes the level of the marginal cost.

We assume that agents and principals are both risk-neutral. Principals maximize their expected profit by offering a compensation scheme \((w_l, w_h)\) to their agent, where \( w_l \) is the agent’s compensation if the firm’s marginal cost is low and \( w_h \) his compensation if the firm’s marginal cost is high. Given that the compensation scheme is accepted agents choose a costly effort level that increases the probability that the cost decreases from high to low. Principal \( i \)’s ex-post payoff is \( U^P_{is} = \Pi_{is} - w_{is} \), where \( \Pi_{is} \) is the profit realized by firm \( i \) in state \( s = h,l \) while \( w_{is} \) is the corresponding transfer to the agent defined by the compensation scheme. The agent’s ex-post utility function is additively separable and depends on his monetary payment and on the cost of effort: \( U^A = w_{is} - C(e) \). We assume \( C(e) \equiv C(p) \), that is choosing a level of effort is identical to choosing a probability of success of a cost reducing innovation (i.e. that the marginal cost is low).

The timing of the game involves 4 stages:

**Stage 1**: Each principal announces privately a compensation scheme \((w_l, w_h)\) to her agent, where \( w_l - w_h \) is the bonus in case of a successful cost-reducing innovation.

**Stage 2**: Each agent decides whether to accept or reject the proposed compensation scheme. In case of a rejection, the game is over and the agent earns zero. If he accepts the compensation scheme, the agent moves to stage 3.

**Stage 3**: The agent chooses the probability \( p \in [0,1] \) that the firm’s marginal cost be reduced, with a cost of effort \( C(p) = \frac{1}{2}p^2 \) where \( \gamma > 0 \).

**Stage 4**: The success of the cost reducing activity is determined stochastically according to the probability chosen by the agent in stage 3: with probability \( p \) the cost will be low. Finally, the realized marginal costs become common knowledge and firms compete “à la Cournot” on the product market.

2.3 Monopoly payoffs

Since the monopolistic firm faces the whole market demand, its profit is \( \Pi = (a - q - c)q \), where \( c \in \{c_l, c_h\} \) and \( q \geq 0 \) is output. The monopoly profit is maximized at output level \( q(c) = \frac{a-c}{2} \), which yields a profit \( \Pi(c) = \left(\frac{a-c}{2}\right)^2 \). The monopoly profit is then given by \( \Pi_h = \left(\frac{a-c_h}{2}\right)^2 \) if the cost is high and \( \Pi_l = \left(\frac{a-c_l}{2}\right)^2 \) if the cost is low. It will be useful to define \( \Delta \Pi = \Pi_l - \Pi_h \) the expected surplus that the monopoly can realize if its marginal cost is reduced.

The principal chooses a dual option \((p, w)\), \( w = (w_l, w_h) \), which solves:
\[
\max_{(p,w)} E(\Pi_i) = p(\Pi_t - w_i) + (1-p)(\Pi_h - w_h)
\] (1)

subject to:
\[
p \in \arg \max_{p \in [0,1]} \hat{p}w_t + (1-\hat{p})w_h - C(\hat{p}) \quad \text{(IC)}
\]
\[
p w_t + (1-p)w_h - C(p) \geq 0 \quad \text{(IR)}
\]
\[
w_s \geq 0, \text{ for } s = l, h \quad \text{(WC)}
\]

The constraints (IC), (IR) and (WC) are respectively the incentive compatibility constraint, the individual rationality constraint and the wealth constraint. As usual, the active constraints at the optimum solution are (IC) and (WC), so that the optimal contract that solves the above second best problem in the monopoly case is given by:

\[
\begin{align*}
\begin{cases}
    w_t^M &= C'(p^M) = \frac{\Delta \Pi}{2} \\
    w_h^M &= 0 \\
    p^M &= \frac{w_t^M}{\gamma} = \frac{\Delta \Pi}{2 \gamma}
\end{cases}
\end{align*}
\] (2)

In the monopoly firm, the principal offers no compensation if the marginal cost is high, but if the marginal cost is low, he offers a bonus that increases with the expected surplus of the cost-reduction\(^1\). We assume that \(\gamma > \frac{1}{2} \Delta \Pi\). This assumption guarantees that the level of effort (\(p\)) chosen by the agent is strictly lower than 1.

### 2.4 Duopoly payoffs

Assume now that there are two (initially symmetric) firms, identified by \(i\) and \(j\). Under Cournot competition the profit of firm \(i\) is given by: \(\Pi_i = (a - Q - c_i)q_i\). Equilibrium outputs and profits are \(q_i(c_i, c_j) = \frac{1}{3} (a - 2c_i + c_j)\), and \(\Pi_i(c_i, c_j) = \frac{1}{9} (a - 2c_i + c_j)^2\), for \(c_i, c_j \in \{c_1, c_h\}\), and symmetrically for firm \(j\). Firm \(i\)'s profit is then given by \(\Pi_{hh} = \frac{1}{9} (a - c_h)^2\) if both costs are high, \(\Pi_{hl} = \frac{1}{9} (a - c_l)^2\) if both costs are low, \(\Pi_{lh} = \frac{1}{9} (a - 2c_l + c_h)^2\) if cost of firm \(i\) is high and cost of firm \(j\) is low and \(\Pi_{lh} = \frac{1}{9} (a - 2c_l + c_h)^2\) if cost of firm \(i\) is low and cost of firm \(j\) is high.

Principal \(i\) selects a dual option \((p_i, w_i)\), \(w_i = (w^i_l, w^i_h)\), which solves:

\[
\max_{(p,w)} E(\Pi_i^i) = p^i [p^i(\Pi_{lt} - w^i_l) + (1-p^i)(\Pi_{lh} - w^i_l)] \\
+ (1-p^i) [p^i(\Pi_{ht} - w^i_t) + (1-p^i)(\Pi_{hh} - w^i_h)]
\] (3)

subject to:
\[
p^i \in \arg \max_{p^i \in [0,1]} \hat{p}^i w^i_t + (1-\hat{p}^i)w^i_h - C(\hat{p}^i) \quad \text{(IC)}
\]
\[
p^i w^i_t + (1-p^i)w^i_h - C(p^i) \geq 0 \quad \text{(RC)}
\]
\[
w^i_s \geq 0, \text{ for } s = l, h \quad \text{(WC)}
\]

\(^1\) Schmidt (1997) analyzes a model where the manager supports a cost \(L\) of work investigation if the firm is liquidated which happens with probability \(l\). He shows that the manager obtains zero compensation when marginal cost is high and \(C'(p) < L\) when marginal cost is low. If the cost of search for the work is equal to zero in the Schmidt’s model, the result is the same.
The optimal contract solving the second best problem in the duopoly case is given by:

\[
\begin{align*}
&w_h^D = 0 \\
&w_l^D = C'(p^i) = \frac{\gamma(\Pi_{lh} - \Pi_{hh})}{2\gamma - (\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh})} \\
&p^D = \frac{w_p^D}{\gamma} = \frac{\Pi_{lh} - \Pi_{hh}}{2\gamma - (\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh})}
\end{align*}
\]  

(4)

According to (4) the optimal compensation schemes of the duopoly and the monopoly firms are identical: the compensation is equal to zero under high cost and equal to the marginal cost of effort if the effort successfully reduces the firm’s cost. Under the assumption \( \gamma > \frac{1}{2} \Delta \Pi \) the level of effort of the agent in the duopoly case is strictly lower than 1. Note that uniqueness of the optimum contract is an immediate consequence of the convexity of the cost-function. Hermalin (1994) showed that if the cost function is linear \( C(p) = pw_l + (1-p)w_h \) an asymmetric equilibrium may obtain for which one of the owners proposes stronger incentives to his manager than the rival owner. Such a possibility is ruled out in our case because \( C(p) \) is convex. The unique Nash equilibrium is a symmetric equilibrium, where the two principals offer the same contract to their agent and where both agents choose the same level of effort.

### 2.5 Comparison between Monopoly and duopoly

In this section we compare the optimum level of effort provided by agents under monopoly and duopoly when the principal chooses the optimum compensation scheme. Under which conditions will agents exert more effort when two agencies compete with each other? Let \( p^M \) and \( p^D \) be the equilibrium efforts under monopoly and duopoly respectively, and assume that the assumption \( \gamma > \frac{1}{2} \Delta \Pi \) is satisfied. We have:

\[
\begin{align*}
p^M &= \frac{\Delta \Pi}{2\gamma} - \frac{\Pi_{lh} - \Pi_{hh}}{2\gamma - (\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh})} \\
p^D &= \frac{\Pi_{lh} - \Pi_{hh}}{2\gamma - (\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh})}
\end{align*}
\]

\[p^M > p^D \quad \text{if:} \quad \frac{\Delta \Pi}{2\gamma} \geq \frac{\Pi_{lh} - \Pi_{hh}}{2\gamma - (\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh})}
\]

(5)

The managerial incentives and the manager’s effort increase in the duopoly case – compared to the monopoly case - if the following conditions are satisfied:

1. \( \Delta \Pi < \Pi_{lh} - \Pi_{hh} \)  
2. \( \gamma > \frac{\Delta \Pi ((\Pi_{lh} - \Pi_{hh} - \Pi_{hl} + \Pi_{hh}))}{\Delta \Pi ((\Pi_{lh} - \Pi_{hh}))} \)

(6)  

(7)

These conditions ensure that the equilibrium effort in the duopoly case exceeds the equilibrium effort in the monopoly case. This may happen in two situations. The first one is when \( \Delta \Pi \geq \Pi_{lh} - \Pi_{hh} \): the entry of an inefficient firm (high cost) reduces the gain of a cost reduction. Therefore, the competing firms have less incentive to reduce their production costs. Consequently, they offer lower incentives to their managers who exert a lower level of effort.

In the second situation \( \Delta \Pi < \Pi_{lh} - \Pi_{hh} \): the entry of an inefficient firm (high cost) increases the gain of a cost reduction. In this case, the firm will offer stronger incentives if and only if
the marginal cost of the effort increases at a sufficiently high rate \( C''(p_i) = \gamma \geq \frac{\Delta \Pi (\Pi_{ll} - \Pi_{lh} + \Pi_{hl})}{\Delta \Pi - (\Pi_{lh} - \Pi_{hh})} \). If this condition is not satisfied, the firm is better off by offering low incentives which will lead the manager to exert low effort. On the other hand if there is a strong increase of the marginal cost of effort, the owner’s implementation cost of effort becomes larger both under monopoly and duopoly. The entry of low-cost firm always reduces the gain of a cost reduction \( (\Delta \Pi \geq \Pi_{ll} - \Pi_{hl}) \). Therefore the owner of the monopoly firm offers stronger incentives to his manager than the duopoly owners. The reason is simple: Cournot competition reduces the output and consequently the gain of a cost reduction. Owners are therefore less inclined to propose high compensation for a cost reducing effort and consequently managers’ efforts are weaker. As a result increased competition (in the form of duopoly vs. monopoly) has a negative effect on the manager incentives and on the effort level.

3. Experimental Design

The main purpose of our experiment was to test the above prediction, by comparing a monopoly situation to a duopoly situation, on the basis of a within subject analysis. We set up a parametric version of the above model, for which we introduced additional simplifications in order to focus exclusively on incentive schemes and effort choices. Before presenting the predictions of the parametric version of our model, we outline the general feature of the experimental design.

3.1 General features

The experiment was organized in the experimental laboratory of LEEM, Montpellier, France. Participants were graduate students from various disciplines (e.g., economics, law, sciences, pharmacy, medical studies). In each session, 20 student-subjects were randomly assigned either to the role of a principal (player X in the instructions) or to the role of an agent (player Y). Participants were privately informed about their assignment which was kept constant over the whole session. No subject participated in more than one session. In total 240 students participated in the experiment (12 sessions × 20 subjects). All participants were involved both in the monopoly game and the duopoly game. Each session consisted therefore of two main sequences: in one of the sequences, participants played the monopoly game for 10 rounds and in the other sequence they played the duopoly game for 10 rounds. To control for ordering effects that could be induced by the introduction of the withdrawal of the competitive pressure, we ran two different treatments: the Monopoly-Duopoly treatment (MD thereafter) and the Duopoly-Monopoly treatment (DM thereafter). We organized six sessions per treatment. In treatment MD, subjects started the monopoly sequence followed by the duopoly sequence. In the DM treatment the order of the sequences was reversed. Specific instructions were provided at the beginning of each sequence. Furthermore, subjects had to answer a short questionnaire that allowed us to check their correct understanding of the instructions. After the first sequence, there was a short break during which the instructions for the next sequence were distributed (see the Appendix). Subjects could not communicate with each other during the break.

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2 The computer program was realized by Dimitri Dubois.
Each treatment was preceded by a practice sequence. Because the duopoly game is much more complex than the monopoly game, we introduced the same practice sequence which consisted of 5 monopoly rounds in both treatments. This allowed us to check whether subjects had the same familiarity with the decision tasks in both treatments, and started the real game with the same understanding of the game. The practice rounds also allow controlling for learning effects which could differ according to treatments (Kagel & Roth, 1995). Pilot sessions showed that subjects assigned to the MD treatment learned more quickly than those assigned to the DM treatment when the practice rounds were absent.

(Insert Table 1 about here)

In order to control for reputation effects, we rely on a stranger matching. At the beginning of each round, each subject in the role of a principal was randomly matched with an agent. In each round of the duopoly sequence, each randomly formed player pair (a principal and an agent) was randomly matched with another pair (a principal and an agent). At the end of each round, new principal-agent pairs were randomly formed, and each such pair was randomly assigned to another pair. In the monopoly sequences, there was no interaction between the different pairs. Interaction was restricted to the principal and the agent of the same pair. Costs, payoffs, and outcomes were measured in ECU (experimental currency units). At the end of the experiment, each subject was paid in cash according to his cumulative payoff for one of the two sequences selected randomly (practice rounds were not paid out). The average (median) payment was equal to 20.01 (20.05) Euros (SD = 2.71) in addition to the show up fee (7.5 Euros).

In each round, the principal could either be in a good state (“Green State” in the instructions) or in a bad state (“Blue State” in the instructions). As in the model, each round was divided into four stages:

In stage 1, the principal offered a contract to his agent for the current round. To simplify the principal’s task, the contract offer only determined the agent’s payment (w) for the “good state”. The principal could choose any contract offer ranging from 6 to 108 ECUs, with increments of 6 units: \(w \in \{6, 12, 18, \ldots, 102, 108\}\). Contract offers within a player pair where common knowledge only to the player pair.

In stage 2, the agent had to decide whether to accept or to reject the contract offer. In case of a rejection the agent’s payoff is zero and the principal is in the “bad state”.

In stage 3 the agent who accepted the contract offer had to choose the probability \(p\) that the “good state” obtains for the pair. The possible values for \(p\) ranged from 9% to 99% by increments of 9%, i.e. \(p \in \{9\%, 18\%, 27\%, \ldots, 90\%, 99\%\}\). The value of \(p\) chosen by the agent was not observable to the principal. To each possible value of \(p\) corresponded a cost of effort for the agent which is shown in table 2.

In stage 4 players were informed about the realized state (for each player in the duopoly case) and the realized individual payoff of each member of their pair. Furthermore, at the end of each round, subjects received the following summary data: the principal’s contract offer, the agent’s acceptance decision, the realized state for the pair and the realized payoffs. Note that in the duopoly sequence the principal was also informed about the state realized for the rival pair.
The chosen design allows us to identify the impact on incentives and effort of a change in the level of profit of the firm following a change in competitive pressure. In the experimental setting the principal has exactly the same information under duopoly than under monopoly and competition does not affect the manager’s utility. Since we control for the informational effect and the manager’s utility effect, we are able to isolate the income effect. The manager should react to the incentives exactly the same way under duopoly than under monopoly.

3.2 Parametric setting

We set the following parameters in the experiment: \( P(Q) = 100 - Q, c_h = 88, c_l = 76 \). We chose \( \gamma = 60 \), so that the cost of effort function is \( C(p) = 30p^2 \). The monopoly profit is \( \Pi_h = 36 \) in the “bad state” (high cost) and \( \Pi_I = 144 \) if the “good state” (low cost). With these parametric settings the optimum compensation scheme offered by the principal in the monopoly case is \( (w_l = 54, w_h = 0) \), and the optimum level of effort chosen by the agent is \( p^M = 90\% \). In equilibrium, the expected surplus sharing in monopoly is 33\% for the agent and 66\% for the principal. Given the optimum compensation scheme, the agent earns zero if he rejects the offer. If he accepts the contract offer, his payoff depends on the realized state for his player pair. He earns \( w - C(p) \) in the “good state” and \( -C(p) \) in the “bad state”. Table 3 summarizes the various possible cases.

The principal’s payoff depends on the sequence. In a monopoly round, he earns \( 144 - w \) in the “good state” and \( 36 \) in the “bad state”. In a duopoly round, principals’ profits depend not only on the state of their own pair, but also on the state of the rival pair. Table 4 summarizes the payoffs of the principal and the agent for each competing player pair identified as pair 1 (P₁) or pair 2 (P₂). While the agents’ payoffs are the same as in the monopoly case, the principals payoffs depend on whether both firms are in the same state or not. We need to consider 4 possibilities: i) both firms are in the “bad state”: each one has a profit equal to \( \Pi_{hh} = 16 \), ii) both firms are in the “good state”: each one makes a profit of \( \Pi_{ll} = 64 \). One firm is in the “good state” and her opponent if in the “bad state”: the profit of the low-cost firm is \( \Pi_{lh} = 144 \) and the high-cost firm’s profit is \( \Pi_{hl} = 0 \). The optimum duopoly compensation scheme offered by each principal is \( (w_l = 42, w_h = 0) \), and the optimum effort level chosen by each agent is \( p^D = 70\% \). In equilibrium, the expected surplus sharing in duopoly is 30\% for agent and 70\% for the principal. Therefore, our model predicts that the entry of a new firm on the market reduces the incentives proposed by the owner to his manager who adjust her level of effort towards a lower level.

4. Experimental Results

In this section we present and discuss our main findings. We set the rejection threshold of the null hypothesis at 5\% for all statistical tests. We make use of the following abbreviations: KS for Kolmogorov-Smirnov, MWU for Mann Whitney Unilateral test, Wilcoxon for Wilcoxon signed rank test and t-test for Student test. M-MD identifies the monopoly sequence in the
MD treatment and D-MD identifies the duopoly sequence in the MD treatment. Similarly, M-DM and D-DM are the obvious counterparts for the DM treatment. We start with the principals’ contract offers before presenting the agents’ decisions.

4.1. Contracts Offers

In this subsection we summarize the principals’ decisions. The average contract offered by monopolistic principals is 55.6 in M-MD and 51.6 in M-DM a non-significant difference (MWU, p-value=0.521). These values do not differ from the theoretical prediction, i.e. contract $w^M = 54$ (t-test, p-value=0.474 for M-MD and p-value=0.398 for M-DM).

In the duopoly case, the average contract offer is 48.9 for D-MD and 45.3 for D-DM a non-significant difference (MWU, p-value=0.336). However average offers are significantly larger than the predicted contract $w^D = 42$ (t-test, p-value=0.024 for D-MD and p-value=0.041 for D-DM): they exceed the predicted contract by 16.43% and 7.86% in D-MD and D-DM respectively.

(Result 1: On average, principals offer lower payments in the duopoly situation than in the monopoly situation.

Table 5 shows that the average contract in the monopoly sequence exceeds the average contract offer in the duopoly sequence for each of the six groups for both treatments. Principals propose a significantly larger compensation under monopoly than under duopoly in both treatments. Indeed, in the MD treatment the average contract offered by the duopolistic firm is significantly lower than the contract offered by a monopolistic firm (Wilcoxon one-sided p-value=0.027). Similarly in the DM treatment the average duopoly contract is significantly lower than the average monopoly contract (Wilcoxon one-sided p-value=0.027).

(Figure 1 shows the evolution of the average contract over time for each treatment. The figure clearly shows that by moving from the monopoly to the duopoly condition (period 10 of the MD treatment), principals react immediately by offering a lower compensation to their agent. Symmetrically, after switching from the duopoly to the monopoly condition (period 10 of DM treatment), principals offer immediately a larger compensation to their agent.

One can see from figure 1 that the withdrawal of competition (treatment DM) has a stronger impact than the introduction of competition (treatment MD). The average variation of the contract offer between period 10 and period 11 is 5.3 points for MD and 9.2 for DM, while the predicted variation is equal to 12 points. The reason why former monopolists lower their contract offer so little may be due to a greater expected fear of rejection after a downward adjustment of their contract offer. Such tempering effect is absent when one moves from the duopoly to the monopoly situation because the agents receive now a better offer than before. Downward wage rigidity has been largely documented (see e.g. Babecky et al., 2010) and has many potential causes. The fact that we also observe it in the lab provides additional evidence of its pervasiveness and that downward rigidity is probably also grounded on behavioral underpinnings.
Despite of the observed asymmetric adjustment of the contract offer, the compensation offered by the principal does not differ between the two treatments (MD vs DM), neither in the monopoly condition ($p = 0.389$) nor in the duopoly condition ($p = 0.333$).

In accordance with our theoretical prediction we observe that on average principals propose a compensation to their agent that is larger in the monopoly condition than in the duopoly condition in both treatments. A reduction (increase) of the expected profit affects negatively (positively) managerial incentives. Principals react immediately to a change in their expected profit by revising their contract offers in the predicted direction.

Result 2: Consistent with our theoretical prediction the expected surplus share is favorable to the principal in the monopolistic environment. However in contrast to our theoretical prediction, the expected surplus share is more favorable to the agent in the duopoly condition.

Table 6 shows the agent’s expected surplus share (ESS), i.e. the agent’s expected net payment divided by the total expected surplus assuming that he chooses optimally the level of effort$^3$. For the monopolistic firm, the agent’s ESS is 39.5% in M-MD and 34.3% in M-DM an insignificant difference (MWU $p$-value=0.229). However, the ESS is significantly larger than predicted by our model, i.e. 33.3% (t-test, $p$-value=0.016).

In duopoly firms, the ESS averages 52.8% in D-MD and 44.9% in D-DM, a non-significant difference (MWU $p$-value=0.336). But as for the monopoly case, the ESS is significantly larger than predicted i.e. 30% (t-test $p$-value<0.001).

Finally, we also observe that the ESS is significantly larger in the duopoly environment than in the monopoly environment for both treatment (Wilcoxon one-sided $p$-value=0.027 for monopoly vs. duopoly in MD and in DM). Compared to the equal split benchmark, the ESS is significantly lower than 40% in the monopoly case (t-test, $p$-value<0.001) but significantly larger than 50% in the duopoly case (t-test, $p$-value=0.006).

We therefore conclude that in a monopolistic environment the expected surplus is shared in a way that favors the principal as predicted. However, when competition is introduced, the sharing of the expected surplus becomes favorable to the agent in contrast to the theoretical prediction.

In summary, in spite of the reduction of the average payment in duopoly, this payment is larger than the predicted payment and the surplus sharing is more favorable to the agent.

\[
ESS = \frac{p'w - 30p'^2}{|p'w - 30p'^2| + |p'(144-w)+(1-p')36|}
\]

$^3$
4.2. Agents’ Decisions

(Table 7 about here)

Table 7 shows the rates of acceptance of contract offers by agent-subjects. Theoretically all contracts should be accepted (since the participation constraint is always satisfied). Agents accepted 86.8% of the monopoly contract offers in M-MD and 92.3% in M-D, an insignificant difference (MWU p-value=0.148). Similarly the rates of acceptance of contract offers by duopoly firms is 91.2% in D-MD and 89.5% in D-DM an insignificant difference (MWU p-value=0.627). But the key observation is acceptance-rates are the same in the duopoly conditions than in the monopoly conditions (Wilcoxon one-sided, p-value=0.248 for monopoly vs. duopoly in DM and p-value=0.207 for monopoly vs. duopoly in MD). Approximately 10% of the contracts are rejected in each sequence, in accordance with earlier findings about contract offers (Clark et al. (2010), Keser and Willinger (2000)).

Result 3: Given the level of compensation, the introduction of competition increases the probability that agents accept the contract offer.

We use a panel data regression in order to estimate the acceptance probability of a contract offer and to identify the variables that have a significant impact on the acceptance decision. The acceptance probability of subject $i$ in period $t$ is given by:

$$ p(A_{it} = 1) = \frac{e^{Z_i}}{1 + e^{Z_i}} $$

where $Z_i = \alpha + \beta_1 P_{it} + \beta_2 \Delta P_i + \beta_3 M + \mu_i + \varepsilon_{it}$.

$P_{it}$ is the payoff of subject $i$ in period $t$, $\Delta P_i$ and $M$ are dummy variables indicating respectively the payoff difference between period $t$ and period $t-1$ (1 if the difference is strictly negative) and the sequence (1 for monopoly). $\mu_i$ is a normally distributed random variable that captures the individual random effect and $\varepsilon_{it}$ is a standard random error term. The results of the random-effects panel regression are summarized in table 8. The Wald test shows that the models are globally significant.

(Insert Table 8 about here)

An increase of the payoff has a positive and significant impact on the acceptance probability. As the payoff variation becomes larger (in the negative domain) the acceptance probability becomes lower. Indeed, the results indicate a positive relationship between payoff and acceptance probability both under monopoly and under duopoly. On the other hand, a lower payoff in the current period than the one offered in the previous period reduces the probability that the agent accepts the contract. The estimates also show that the sequence dummy is significantly and negatively correlated to the acceptance probability in treatment MD but not in treatment DM: by switching from monopoly to duopoly, with lower incentives, the probability that the agents accept the contract increases significantly, while moving from duopoly to monopoly, with higher incentives, does not affect the acceptance probability. Since agents accept lower payment in duopoly firms, they are sensitive to the competitive environment to which their principal is exposed.

\[ E(U^A) = pw_1 - c(p) = pc'(p) - c(p) = \frac{\gamma}{2} p^2 > 0. \]
We suspect that the main reason why agents reject contract offers is that they expected a more favorable offer. This is confirmed by a logit estimate of the reject probability of the contract offer as a function of the ESS. The results of the random-effects panel regression are summarized in Table 9.

The Wald test shows that the models are globally significant. An increase in the ESS has a negative and significant impact on the probability to reject the contract offer. This observation is in line with Anderhub et al. (2002) and Cochard and Willinger (2005) who found a similar result. Therefore, the agent’s decision to accept or reject is based on the comparison of his net payment and the principal’s payment: if the principal’s payoff is comparatively too large the agent rejects the offer.

Table 10 shows the average effort level (and standard error) chosen by the agents after accepting a contract. In monopoly, the average effort is 68.8% in the MD treatment and 71.2% in the DM treatment, a non-significant difference (MWU p-value=0.423) but these effort levels are significantly lower than the optimal effort, i.e. effort $p^* = 90\%$ for both treatments ($t$-test p-value=0.001 for both treatments). In duopoly, the average effort is 69.2% in the MD treatment and 66.4% in the DM treatment, which are statistically not different (MWU, p-value=0.521) nor from the theoretical prediction, i.e. effort $p^* = 70\%$ ($t$-test p=0.344 for MD and p-value=0.113 for DM).

Result 4: The reduction of the average payment after entry of a rival firm has no effect on the agent’s average effort level. On the other hand, the increase of the average payment after the exit of the rival firm increases significantly the average effort level.

The average effort level is not significantly different across sequences of the MD treatment (KS p-value=0.756). On the other hand, in the DM treatment the level of effort is significantly larger in the monopoly condition compared to the duopoly condition (KS p-value=0.049). The analysis of the evolution of the average effort over time confirms the absence of significant differences across sequences for the MD treatment (MWU p-value=0.705), but a significant one in the DM treatment (MWU p-value<0.000).

Therefore our data reflects an asymmetric reaction on the part of the agents: when the expected profit becomes weaker following the firm’s entry, principals offer higher incentives and agents respond by providing higher effort. However, when the competition is reinforced, principals offer lower incentives because of reduced profit expectations, but agents maintain their effort level.

Result 5: For a given level of payment, agents work harder in the duopoly environment than in the monopoly environment. The effort level is positively correlated to the payment and negatively to the payment variation.

Table 11 shows the results of a fixed-effects panel regression, with effort choice as the dependent variable.
The results show that the effort level is strongly correlated to the contract payment in both treatments. For a given income, effort is significantly lower if the payment received in the previous period is higher than the payment in the current period. In contrast, if the payment is higher in the current period the agent increases her effort.

The estimates show also that the sequence dummy is significant and negatively correlated with effort in both treatments: for the same payment, agents work harder in the duopoly environment than in the monopoly environment.

Finally, when deciding to accept or to reject a contract offer, the agent compares his net payment to the principal’s payment. He tends to refuse contract offers with unequal sharing. After a decrease in incentives following an increase in competition, agents tend to reduce their acceptance threshold and maintain their effort level.

5. Conclusion

We provide experimental evidence about managers’ effort choices after firm owners adjust their contract offer in response to increased (reduced) competition. There exists a consensus in the theoretical literature about the existence of a monotonic relation between competition on one hand and firm’s profit, incentives and effort on the other hand: when competitive pressure reduces (increase) the firm’s profit, the firm lowers (increases) the incentives provided to its manager who reduces (increases) his effort.

According to the available empirical literature, increased competition tends to increase the incentives and the effort levels and to decrease agency costs. Empirical studies are however bounded by obvious data limitations: relevant variables such as effort or the strength of competition are difficult to observe or to measure, and therefore testing the relationship between these variables is hardly feasible.

We contribute to the existing literature by providing experimental evidence. Our experiment is based on a simple model in which we compare a monopolistic firm to duopoly firms that compete “à la Cournot”. Each firm has an owner (the principal) and a manager (the agent). The principal offers a compensation to his agent if the firm’s production cost is low. The agent chooses a costly level of effort in order to reduce the production cost. The agent’s effort is unobservable to the principal.

Our key finding is that when the increase of competitive pressure (entry of a rival firm) reduces the firm’s profit, the firm’s owner lowers the incentives provided to his manager. However, instead of reducing it as predicted, managers maintain their level of effort. Such reaction contradicts the hypothesis according to which there exists a monotonic relation between competition, profit, incentives and effort. We also find that this effect is asymmetric: after the withdrawal of a rival firm, the firm’s profit increase and principals offer higher incentives to their managers who increase their effort level. We also observe that agents reject unfair contracts: while they usually share the principal’s objective, they are reluctant to accept unfair contracts.

Our results support previous empirical findings according to which, in a competitive market the productivity is higher (Nickel, 1996) and agency costs are lower (Jagannathan and Srinivasan, 1999; Griffith, 2001). Our data agree with the conjecture that competition has a
positive effect on managerial effort. Managers internalize to some extent the firm’s concern about the competitive environment. Instead of adjusting mechanically downwards their level of effort to the incentives offered by the firm’s owner, managers react to increased competition by maintaining a high level of effort. As outside competition becomes more aggressive, managers are more likely to increase rather than to lower their efforts, in order to reduce the firm’s costs despite of the lower incentives.

We interpret our findings by relying on an *internalization effect* of competition that encourages the manager to maintain a high level of effort. This effect support Hart’s idea of substitutability between incentives and competition and the predictions of Hermalin (1992) and Schmidt (1997) that higher competition induces higher effort without stronger incentives. But increased competition has also an *income effect* that encourages the manager to provide lower effort. If competition reduces the firm’s profit, the owner reduces incentives which lead the manager to provide lower effort. The two effects – *internalization and income* - have opposite signs and therefore the overall impact of competition on effort is neutral: competition reduces the profit and incentives but the manager maintains its effort level.
References


Table 1: Experimental design

<table>
<thead>
<tr>
<th>Treatment</th>
<th>First sequence</th>
<th>Second sequence</th>
<th>Third sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>MD Treatment</td>
<td>Training (5 periods)</td>
<td>Monopoly (10 periods)</td>
<td>Duopoly (10 periods)</td>
</tr>
<tr>
<td>DM Treatment</td>
<td>Duopoly (10 periods)</td>
<td>Monopoly (10 periods)</td>
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</tr>
</tbody>
</table>

Table 2: The cost associated with each value of $p$

<table>
<thead>
<tr>
<th>$p$ (%)</th>
<th>9</th>
<th>18</th>
<th>27</th>
<th>36</th>
<th>45</th>
<th>63</th>
<th>72</th>
<th>81</th>
<th>90</th>
<th>99</th>
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</thead>
<tbody>
<tr>
<td>$C(p)$ (ECU)</td>
<td>0.2</td>
<td>1</td>
<td>2.2</td>
<td>3.9</td>
<td>6.1</td>
<td>8.7</td>
<td>11.9</td>
<td>15.6</td>
<td>19.7</td>
<td>24.3</td>
</tr>
</tbody>
</table>

Table 3: Agent's and Principal's payoffs under monopoly

<table>
<thead>
<tr>
<th>State</th>
<th>Agent payoff in case of refusal</th>
<th>Agent payoff in case of acceptance</th>
<th>Payoff of the principal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good</td>
<td>0</td>
<td>$w - C(p)$</td>
<td>144 - $w$</td>
</tr>
<tr>
<td>Bad</td>
<td>0</td>
<td>- $C(p)$</td>
<td>36</td>
</tr>
</tbody>
</table>

Table 4: Possible payoff in duopoly in the event of acceptance of the contracts

<table>
<thead>
<tr>
<th>State</th>
<th>Payoff of principal</th>
<th>Payoff of the agents</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$P_1$</td>
<td>$P_2$</td>
</tr>
<tr>
<td>Good</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Good</td>
<td>Good</td>
<td>Bad</td>
</tr>
<tr>
<td>Bad</td>
<td>Good</td>
<td></td>
</tr>
<tr>
<td>Bad</td>
<td>Bad</td>
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</table>

Table 5: Average contract offer

<table>
<thead>
<tr>
<th>Treatment</th>
<th>MD</th>
<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence</td>
<td>Monopoly</td>
<td>Duopoly</td>
</tr>
<tr>
<td>Prediction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G1</td>
<td>63.8 (14.6)</td>
<td>61.4 (12.1)</td>
</tr>
<tr>
<td>G2</td>
<td>48.4 (16.1)</td>
<td>46.0 (14.1)</td>
</tr>
<tr>
<td>G3</td>
<td>56.1 (11.5)</td>
<td>47.2 (9.3)</td>
</tr>
<tr>
<td>G4</td>
<td>57.0 (18.1)</td>
<td>47.8 (10.7)</td>
</tr>
<tr>
<td>G5</td>
<td>55.0 (10.5)</td>
<td>48.8 (8.4)</td>
</tr>
<tr>
<td>G6</td>
<td>53.3 (15.7)</td>
<td>42.2 (10.9)</td>
</tr>
<tr>
<td>Total</td>
<td>55.6 (14.4)</td>
<td>48.9 (10.9)</td>
</tr>
</tbody>
</table>
Figure 1: Evolution of average compensation over time

Table 6: Agent’s Expected Surplus Share

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sequence</th>
<th>Predictions</th>
<th>MD</th>
<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monopoly</td>
<td>33.3%</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>G1</td>
<td>Duopoly</td>
<td>47.9%</td>
<td>81.9%</td>
<td>71.4%</td>
</tr>
<tr>
<td>G2</td>
<td>Duopoly</td>
<td>33.8%</td>
<td>41.1%</td>
<td>50.5%</td>
</tr>
<tr>
<td>G3</td>
<td>Monopoly</td>
<td>38.2%</td>
<td>42.7%</td>
<td>34.9%</td>
</tr>
<tr>
<td>G4</td>
<td>Monopoly</td>
<td>42.8%</td>
<td>45.4%</td>
<td>38.0%</td>
</tr>
<tr>
<td>G5</td>
<td>Monopoly</td>
<td>36.5%</td>
<td>71.6%</td>
<td>42.0%</td>
</tr>
<tr>
<td>G6</td>
<td>Monopoly</td>
<td>37.7%</td>
<td>33.7%</td>
<td>32.4%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>39.5%</td>
<td>52.8%</td>
<td>44.9%</td>
</tr>
</tbody>
</table>

Table 7: Rate of acceptance of contracts

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Sequence</th>
<th>Prediction</th>
<th>MD</th>
<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monopoly</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>G1</td>
<td>Duopoly</td>
<td>91.0%</td>
<td>100.0%</td>
<td>96.0%</td>
</tr>
<tr>
<td>G2</td>
<td>Duopoly</td>
<td>85.0%</td>
<td>82.0%</td>
<td>86.0%</td>
</tr>
<tr>
<td>G3</td>
<td>Monopoly</td>
<td>95.0%</td>
<td>96.0%</td>
<td>80.0%</td>
</tr>
<tr>
<td>G4</td>
<td>Monopoly</td>
<td>88.0%</td>
<td>96.0%</td>
<td>93.0%</td>
</tr>
<tr>
<td>G5</td>
<td>Monopoly</td>
<td>86.0%</td>
<td>85.0%</td>
<td>89.0%</td>
</tr>
<tr>
<td>G6</td>
<td>Monopoly</td>
<td>76.0%</td>
<td>88.0%</td>
<td>93.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>86.8%</td>
<td>91.2%</td>
<td>89.5%</td>
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</table>
Table 8: Logistic regression of the acceptance probability of contract offers

<table>
<thead>
<tr>
<th>Treatment</th>
<th>MD</th>
<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb. obs.</td>
<td>1080</td>
<td>1080</td>
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<tr>
<td>Dependent Variable</td>
<td>Acceptance probability</td>
<td>Acceptance probability</td>
</tr>
<tr>
<td>Independent Variables</td>
<td>Coeff. (SD)</td>
<td>Coeff. (SD)</td>
</tr>
<tr>
<td>$P_{it}$</td>
<td>0.154 (0.016)***</td>
<td>0.111 (0.014)***</td>
</tr>
<tr>
<td>$\Delta P_{i}$</td>
<td>-0.800 (0.356)**</td>
<td>-0.840 (0.332)**</td>
</tr>
<tr>
<td>$M$</td>
<td>-1.197 (0.295)***</td>
<td>-0.198 (0.268)</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.474 (0.798)***</td>
<td>-0.624 (0.684)</td>
</tr>
</tbody>
</table>

Wald $\chi^2(3)=125.85$, Prob>$\chi^2=0.0000$, Log likelihood=$-211.551$ for MD
Wald $\chi^2(3)=90.28$, Prob>$\chi^2=0.0000$, Log likelihood=$-215.072$ for DM

*** and ** denote two-tailed statistical significance at the 1% and 5% level, respectively.

Table 9: Logistic estimates of the reject probability of contracts offers

<table>
<thead>
<tr>
<th>Treatment</th>
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<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb. obs.</td>
<td>1200</td>
<td>1200</td>
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<tr>
<td>Dependent variable</td>
<td>Reject probability</td>
<td>Reject probability</td>
</tr>
<tr>
<td>Independent variables</td>
<td>Coeff. (SD)</td>
<td>Coeff. (SD)</td>
</tr>
<tr>
<td>$ESS$</td>
<td>-1.090 (0.253)***</td>
<td>-1.108 (0.335)***</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.903 (0.179)***</td>
<td>-2.769 (0.287)***</td>
</tr>
</tbody>
</table>

Wald $\chi^2(1)=10.94$, Prob>$\chi^2=0.0009$, Log likelihood=$-309.997$ for MD
Wald $\chi^2(1)=18.52$, Prob>$\chi^2=0.0000$, Log likelihood=$-390.216$ for MD

*** denote two-tailed statistical significance at the 1%.

Table 10: Average effort level in accepted contracts

<table>
<thead>
<tr>
<th>Treatment</th>
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<th>DM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence</td>
<td>Monopoly</td>
<td>Duopoly</td>
</tr>
<tr>
<td>Prediction</td>
<td>90%</td>
<td>70%</td>
</tr>
<tr>
<td>G1</td>
<td>60.2% (18.0)</td>
<td>68.3% (16.4)</td>
</tr>
<tr>
<td>G2</td>
<td>60.8% (15.5)</td>
<td>64.1% (18.4)</td>
</tr>
<tr>
<td>G3</td>
<td>70.4% (12.0)</td>
<td>65.9% (11.0)</td>
</tr>
<tr>
<td>G4</td>
<td>71.5% (21.1)</td>
<td>69.8% (10.9)</td>
</tr>
<tr>
<td>G5</td>
<td>79.6% (6.4)</td>
<td>77.7% (4.7)</td>
</tr>
<tr>
<td>G6</td>
<td>70.5% (12.5)</td>
<td>69.3% (11.5)</td>
</tr>
<tr>
<td>Total</td>
<td>68.8%</td>
<td>69.2%</td>
</tr>
</tbody>
</table>
Figure 2: Average effort level according to average payment

Table 11: Determinants of the choice of effort level

<table>
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<th>Treatment</th>
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</tr>
</thead>
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<td>Nb. obs.</td>
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<td>983</td>
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<tr>
<td>NB. of subjects</td>
<td>60</td>
<td>60</td>
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Dependent variable: Effort

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Coeff. (SD)</th>
<th>Coeff. (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Payment&lt;sub&gt;it&lt;/sub&gt;</td>
<td>0.546 (0.039)***</td>
<td>0.604 (0.049)***</td>
</tr>
<tr>
<td>ΔPayment&lt;sub&gt;it&lt;/sub&gt;</td>
<td>-2.255 (1.113)**</td>
<td>-1.959 (1.249)***</td>
</tr>
<tr>
<td>Monopoly</td>
<td>-5.907 (0.916)***</td>
<td>-1.860 (1.096)**</td>
</tr>
<tr>
<td>Constant</td>
<td>44.577 (2.634)***</td>
<td>42.303 (2.529)***</td>
</tr>
</tbody>
</table>

Wald χ²(3)=288.28, Prob>χ²=0.0000, Log likelihood=-4134.539 for MD
Wald χ²(3)=228.82, Prob>χ²=0.0000, Log likelihood=-4307.894 for DM

*** and ** denote two-tailed statistical significance at the 1% and 5% level, respectively.